the data message, and outputs an RS-232 serial data message through an RS232 interface **220**, or as output to 9602 Iridium Modem **160**. The data message format is compatible with the National Data Buoy Center (NDBC) standard Coastal-Marine Automated Network (C-MAN) message format and does not require formatting by the NDBC payload. The smart module of the present invention can switch power to the sensor via wet mate plug **140** as illustrated in FIG. **2**. Some of the details, like how long to measure and average, are configurable through a user interface, which may be wired through wet mate plugs **140** and/or **145** through RS232 interface **220**.

The Smart Sensor Module turns a "dumb" analog sensor into a digital, or "smart", sensor. In one embodiment, for example, the system may be configured to provide a measurement of the Rotronics MP101A (available from Rotronic Instrument Corp, Hauppauge, N.Y.) humidity and temperature signals in the same manner as NDBC payloads (e.g. ARES or AMPS).

An additional wet mate plug **145** may be provided to input additional serial sensor or user interface data, as well as provide power to the smart module custom board **120** from, for example, battery bank **330** or solar panels **320** on data buoy **310**. Of course, other power sources may be used, depending on system location and installation. Power from commercial power systems (e.g., 110 VAC) may be utilized for a land-based system, through suitable transformers (e.g., wall-pack or the like) with a battery backup provided. Solar panels or even automotive power sources (for mobile devices) may also be applied. In marine environments, other power sources, such as wave-power generated electricity, may be used, without departing from the spirit and scope of the present invention.

Sensor data or user interface data in serial form may be fed through serial RS232 interface **220**, which in turn may transmit data to MSP430 processor **240**. Power conditioning circuit **230** receives input power from batteries, solar panels, or the like, and filters the power input and outputs appropriate voltages for the various devices in the apparatus, such as 3.3 Volts, 5 Volts, or the like, as well as switched battery power as a backup.

In order to prevent confusion in the field and a possible misconnection of plugs, wet mate plug **140** may be female and wet mate plug **145** may be male. In this manner, a technician installing the device on a data buoy or other difficult environment does not have to remember which plug is which, and the possibility of power being fed into data circuits and vice-versa is eliminated.

Sensor data and other data may be processed in MSP430 processor **240** and then output to 9602 Iridium modem **160** for transmission via L-band antenna **110** to a central processing site, where such data is collected and analyzed as is known in the art. L-band antenna **110** also receives GPS data, which is processed by GPS receiver **270** to provide position data to MSP430 processor **240**. Position data may be transmitted as part of an overall data feed in normal use, and/or may be transmitted, as will be described below, as part of a backup emergency locator system, to provide location transmitting capabilities for lost data buoys and the like.

Data may also be output or received through XBee interface **280**. XBee is the brand name of a family of form-factor compatible radio modules manufactured by Digi International of Minnetonka, Minnesota. XBee radios are based on the 802.15.4-2003 standard designed for point-to-point and star communications at over-the-air baud rates of 250 Kbit/s. The XBee radios can all be used with the minimum number of four connections—power (3.3 V), ground, data in and data out (UART), with other recommended lines being Reset and Sleep. Additionally, most XBee families have some other flow control, I/O, A/D and indicator lines built in. XBee interface **280** may be used to retrieve data locally, either for programming or testing purposes, or to transmit and receive data to other data collection devices.

As previously illustrated in FIG. **2**, the smart module of the present invention includes a single custom printed circuit board **120** with a pluggable XBee Pro, IEEE standard 802.15.4 wireless modem **280**. The printed circuit board contains an MSP430 processor **240**, sensor power switch **230**, RS-232 serial transceiver **220**, and gain circuits for analog signal conditioning **210**. The A/D **260** resides on the MSP430 chip **240**. The smart module of the present invention can switch power to a sensor, read analog signals from the sensor and communicate with a payload or laptop through the RS-232 port **220**. The XBee radio **280** provides a short-range connection to other wireless devices and smart modules.

Compact flash card **290** may be provided to store data for later retrieval, and also to store programming for the MSP430 processor **240**. Using a compact flash card for programming of MSP430 processor **240** allows the functionality of the device to be changed for different applications, simply by changing flash cards. In the preferred embodiment, all the applications are supplied in the program code. A user may access a configuration mode and then select the desired application (e.g., backup transmitter, smart sensor, etc.)

Referring to FIG. **4**, in wireless mode, the smart module of the present invention functions the same as the wired mode except that the smart module at the sensor may communicate with another smart module connected to the payload. The smart module at the sensor is called a "Smart End Device" and the smart module at the payload is called a "Smart Coordinator." As illustrated in FIG. **4**, a number of Smart End Devices **410**, **420**, **430**, and **440** may be provided, each connected via port **140** to a corresponding sensor or sensors A, B, C, and D. Smart End Devices **410**, **420**, **430**, and **440** may be connected wirelessly **470** using XBee interface **280** of FIG. **2**, to another smart module configured as a Smart Module Coordinator **450**. All smart modules **410**, **420**, **430**, **440**, and **450**, whether configured as Smart End Devices or Smart Module Coordinators, may be physically the same or substantially similar. The functionality of each device maybe programmed, either on-site, remotely, or before installation, by altering the programming via compact flash card **290** or by programming through XBee interface **280**, RS 232 interface **220**, or via 9602 modem **160**. Data from Smart Module Coordinator **450** may be sent to Iridium or other type of satellite **480** (or other wireless or wired communications network) to ground station **460**, where data may be collected and analyzed. The modular nature of this design allows the use and re-use of interchangeable modules, rather than relying on custom one-off integrated designs, which are difficult to alter in the field.

Referring back to FIG. **4**, Smart Module Coordinator **450** may communicate wirelessly to one or more Smart End Devices **410**, **420**, **430**, and **440** to acquire data, and then may send this data to the payload on a serial port or other data pathway. Smart Module Coordinator **450** may be programmed to communicate with several Smart End Devices **410**, **420**, **430**, and **440**. In this manner, a number of Smart End Devices **410**, **420**, **430**, **440** may be linked together, and a data buoy or other data station may be upgraded and expanded, without having to reprogram existing sensors A, B, C, and D. The use of linked smart modules allows for a single data channel to be created for multiple modules, limiting the need for multiple modems **160** and antennas **110**. Smart sensor modules may be combined in a number of combinations and communicate wirelessly (or in a wired manner) with each